Utah Guidance for Local Health Departments

Harmful Algal Blooms and Human Health

Version 1.1
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TABLE OF CONTENTS

Sampling of Utah Water Bodies 1
Background on Blue-Green Algae 1
Background on Blue-Green Algae 1
Health Concerns Associated with Blue-Green Algae 2
Posting Health Advisories and/or Beach Closures 4
Guidance for Water Body Sampling 7
Communication with the Public 7
Fish Consumption from High Blue-Green Algae Count Areas 7
Appendix A: Decision-Making Tools and Signage Examples 10
Appendix B: Example Fact Sheet 16

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Introduction

As summer approaches and the weather gets warmer, conditions become more favorable for the growth of potentially harmful blue-green algae in Utah's lakes, ponds, and streams. Blue-green algae blooms in Utah have caused livestock deaths and were suspected of causing human illnesses in the past. Harmful algal blooms are caused by organisms known as cyanobacteria. Though calling them algae is technically inaccurate, this guidance uses the commonly used names "harmful algae" or "blue-green algae."

In 2014, algal blooms resulted in public notifications due to concerns for human health. In response to inquiries from local health department officials, the Utah Department of Health (UDOH) and the Utah Department of Environmental Quality (UDEQ) have reviewed the available literature on health risks associated with blue-green algae and have developed the following harmful algal bloom guidance for local health departments (LHDs). This guidance is designed to assist recreational water decision-making for LHDs, particularly when public notifications and beach closures, may be warranted.

It is important to remember that no one should ingest untreated lake or pond water at any time. All untreated surface waters contain bacteria, algae, viruses, and numerous other pathogens. Consuming untreated water sources may pose serious health risks to humans, pets, and livestock.

Sampling of Utah Water Bodies

While blue-green algae are not new to Utah, UDEQ is increasing its sampling efforts in selected Utah lakes to determine the prevalence of blue-green algae such as *Anabaena*, *Microcystis*, and *Cylindrospermopsis* species. UDEQ regularly collects algal samples from lakes to assess the effects of nutrients in the water and characterize the ecology.

Health officials, natural resources specialists, and the public should become as well-informed as possible regarding the public health issues presented by harmful algal blooms. Local health officials particularly should seek good information to assist them in interpreting sampling results and taking appropriate public health actions. This guidance will assist local health officials and natural resource specialists in using blue-green algae sampling and other indicators of potential harmful algal blooms to make appropriate decisions regarding recreational use of lakes in Utah.

Background on Blue-Green Algae

Blue-green algae are photosynthetic single-celled aquatic organisms that tend to be found living near the surface of lakes or ponds. Their relative abundance in a lake is dependent on a variety of factors such as water temperature and available nutrients. Many types of blue-green algae, and some non-toxic algae, can form visible scums or large floating mats on lake surfaces during an algal bloom. It is important to keep in mind that some species of blue-green algae don't form surface scums, nor do all species of blue-green algae produce toxins.

The concentration of blue-green algae and their toxins can change dramatically on a lake from one location to another and from one day to another. Blooms can cover an entire lake or only isolated areas. When conditions are calm, blue-green algae blooms typically occur or disperse in the time frame of a few days. It is important to note that algal toxins can linger for days after the bloom is no longer visible; also, depending on the type of blue-green algae present, the toxin concentrations in a lake may even increase soon after a bloom disappears. This is due to toxins trapped inside the algae being released to the water when the algae cells die. These factors make it challenging to determine when and what type of public health action is appropriate to address a developing algal bloom.

Health Concerns Associated with Blue-Green Algae

When present in high numbers in recreational waters, blue-green algae can cause eye, ear, and skin irritation. Gastrointestinal symptoms such as vomiting and diarrhea can also result from exposures to blue-green algae. Animals such as dogs and cattle may become sick from eating the blue-green algae surface scum.

Blue-green algae toxins can be classified into two major types: neurotoxins and hepatotoxins. Neurotoxins affect the nervous system; blue-green algae neurotoxins include anatoxin-a, anatoxin-a(s) and saxitoxin. These are commonly produced by the *Anabaena* and *Oscillatoria* species. Animals or humans ingesting these toxins may develop muscle cramps, twitching, paralysis and cardiac or respiratory failure. Symptoms can occur within an hour of exposure, but may take as long as 36 hours to develop.

Hepatotoxins affect the liver; common blue-green algae hepatotoxins include microcystin and cylindrospermopsin. These toxins are produced by the *Microcystis* and *Cylindrospermopsis* species, respectively. These toxins cause symptoms such as nausea, vomiting, and acute liver failure. In general, symptoms will appear rapidly following exposure to high amounts of hepatotoxins, but may take several days in the case of more moderate exposures exposure.

Though the most serious health effect of harmful algal blooms is due to exposure to cyanotoxins, skin rashes can also result from contact with blue-green algae alone.

Table 1. Common Cyanotoxins Expected in Utah[1]

Toxin Type	Genera	Toxins	Symptoms of Exposure
Neurotoxin	*Anabaena*; *Oscillatoria*	Anatoxin-a; anatoxin-a(s); saxitoxin	Muscle cramps; twitching; paralysis; cardiac or respiratory failure; death in animals
Hepatotoxin	*Microcystis*; *Cylindrospermopsis*	Microcystin; cylindrospermopsin	Nausea; vomiting; acute liver failure

[1] Nodularin has been detected in Great Salt Lake but the toxicity data are currently inadequate to make recommendations.

Existing Guidance Regarding Blue-Green Algae

To date, neither the U.S. Environmental Protection Agency (EPA) nor the U.S. Centers for Disease Control and Prevention have issued official regulatory or health-based standards for safe levels of blue-green algae or toxins in recreational waters or drinking water. The EPA is expected to issue drinking water guidelines for certain cyanotoxins in 2015. EPA expects to include guidance for recreational waters in 2016. In the absence of U.S. national standards, the UDOH and UDEQ have provisionally adopted blue-green algae health guidelines based upon those outlined by the World Health Organization (WHO, 2003).

WHO guidelines state:

- A **low** probability for adverse health effects is expected when blue-green algae cell counts are between 20,000 and 100,000 cells/mL. At this level, providing information to bathers is considered sufficient.

- A **moderate** probability for adverse health effects is expected when blue-green algae cell counts are between 100,000 and 10,000,000 cells/mL. Interventions such as restricting bathing at beaches and public education campaigns may be appropriate when blue-green algae counts are at this level.

- A **high** probability for adverse health effects is expected when blue-green algae cell counts are greater than 10,000,000 cells/mL, or there are blue-green algae scums at bathing areas. The WHO reports that animal poisonings and human illnesses related to blue-green algae are usually accompanied by the presence of scum material at the water surface, and that ongoing observation of bathing beaches is necessary to assess the existence of high-risk exposures. Interventions such as restricting bathing at beaches and public education campaigns may be appropriate when blue-green algae counts are at this level.

Many blue-green algal species of concern form clumps, spheres, and/or coils of intertwined cells. Therefore, it is often problematic to quantify cell counts using routine laboratory protocols. It may not be possible in some cases to compare cell densities from any particular lake or pond sample to the guidelines provided by the WHO regarding human risk from exposure to blue-green algae.

Because certain species, such as those within *Cylindrospermopsis*, are not prone to form surface scums when cell counts are high, the WHO guidance for defining high levels of risk is less informative for these species than for others. It is also likely that there is some variation in the degree to which different species of blue-green algae contribute to skin rashes.

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Table 2. WHO Guidelines for Assessing Blue-Green Algae Density in Recreational Water (WHO, 2003).

Relative Probability of Acute Health Risk	Blue-green algae Cell Density (cells/mL)	Health Risks	Action Recommended
Low	20,000-100,000	Short-term effects e.g. skin irritation, gastrointestinal illness	Post risk advisory
Moderate	100,000-10,000,000	As above for low risk, and potential for long-term illness	Post risk advisory & possible closure
High	>10,000,000 or Visible scum layer	As above for moderate risk, and potential for acute poisoning	Closure

Posting Health Advisories and/or Beach Closures

Authority

- A local health department may prepare, publish, and disseminate information necessary to inform and advise the public concerning the health and wellness of the population, specific hazards, and risk factors that adversely affect the health and wellness of the population.
  [UAC, 26A-1-114, (1)(i)(i)]

- A local health department may close theatres, schools, and other public places and prohibit gatherings of people when necessary to protect public health. [UAC, 26A-1-114 (1)(e)]

Guidance

The UDOH and UDEQ recommend that local health departments use **Table 3** and the decision algorithm outlined in **Appendix A**, **Figure A-1** when determining the appropriate level of health risk and public health action for a given water body. In the algorithm, red arrows indicate increasing potential hazard of harmful algal blooms; blue arrows indicate decreasing hazard. As shown in Table 3 and the algorithm, if an LHD receives reports of human or animal illness or death that is plausibly linked to blue-green algae, an immediate public health advisory is recommended. Once an advisory is issued, at least 2 weeks of measurements that indicate that the hazard has passed are recommended before removing the advisory.

The relationship between the cell counts shown in Table 3 and other potential measures (such as toxin

concentrations) that are used to assess hazardous algal blooms are shown in **Appendix A**, Table A-1. In some situations, results for several of these measures may be available. Without any additional site-specific information, the highest level of public health advisory supported by any of the different measures shown in Table A-1 is recommended in order to be as protective of public health as possible.

Examples of CAUTION, WARNING and DANGER signs are included in **Appendix A** (Figures A-2, A-3, and A-4).

Table 3. UDOH/UDEQ Harmful Algal Bloom Decision Guidelines (Based upon WHO, 2003).

Relative Probability of Acute Health Risk	Blue-Green algae Cell Density (cells/mL)	Health Risks	Action Recommended
Very Low	<20,000	Negligible	None
Low	20,000-100,000	Short-term effects e.g. skin irritation, gastrointestinal illness	Issue caution advisory; Post **CAUTION** sign; Weekly sampling recommended
Moderate	100,000 – 10,000,000 **or** reports of animal illnesses or death	As above for low risk, and potential for long-term illness	Issue warning advisory; Post **WARNING** sign; Weekly sampling recommended
High	>10,000,000 **or** thick scum mat layer **or** reports of human illness	As above for moderate risk, and potential for acute poisoning	Issue Danger Advisory; Post **DANGER** sign; Weekly sampling recommended Consider **Closure**

Tiers of Notification

As **Table 3** and **Figure A-1** indicate, UDOH and UDEQ recommend a three-tier approach to HAB notifications. The following is a description of LHD actions at each tier and the types of information that should be considered to substantiate that action.

Tier 1 (Low Probability of Public Health Risk)

This first level of notification informs the public of the potential presence of toxin-producing blue-green algae. As signage indicates **(Figure A-2)**, the public is advised to not swim or boat in areas of scum and to clean fish well after catching. Furthermore, the signs advise the public to keep pets and livestock away from the waters. Indeed, while a recreational exposure (minimal accidental ingestion) to a particular water body in bloom may not result in any health effects in people; an active drinking exposure to the same waters may prove fatal for pets and livestock. At this tier, LHDs should consider the following

actions:

Action:

- LHD should consider posting CAUTION signs when officials are confident that blue-green algae are blooming; postings could be specific to a portion of a waterbody rather than an entire lake or reservoir.
- LHD should notify UDEQ-DWQ of a bloom forming and a sampling plan should be established.
- LHD should also notify
    - Utah Poison Control Center (UPCC)
    - Utah Department of Natural Resources (UDNR), Division of Wildlife Resources (DWR)
    - Utah Department of Natural Resources (UDNR), Division of State Parks (if applicable)
    - UDOH
- Weekly sampling should begin until bloom dissipates (see accompanying monitoring guidance provided by DWQ).
- LHD should consider providing information brochures **(APPENDIX B)** at points of water body access.

***Establishing Rationale/Confidence for Action*:**

- Verify blue-green algae by comparing observations to established web-site pictures (see **More Information** section below).
- Take a picture of the algae forming and send to UDEQ-DWQ

Tier 2 (Moderate Probability of Public Health Risk)

This second level of notification informs the public of the verified existence of blue-green algae in the water at a level that is likely to result in adverse health effects if precaution is not taken. As signage indicates **(Figure A-3)**, the public is advised to not swim or water ski in the water. Boating and fishing can still be enjoyed using precaution, and the public is instructed to keep pets and livestock away from the waters. At this tier, LHDs should consider the following actions:

Action:

- LHD should consider posting WARNING signs when a substantial harmful algal bloom is verified; postings could be specific to a portion of a waterbody rather than an entire lake or reservoir.
- LHD should notify the following agencies that the action level has increased:
    - UDEQ-DWQ
    - UPCC
    - UDNR, DWR
    - UDNR, Division of State Parks (if applicable)
    - UDOH
- LHD should consider providing information brochures **(APPENDIX B)** at points of water body access.
- Weekly sampling should continue until bloom dissipates, more detailed analytical sampling should be considered.
- <u>If</u> sampling indicates that bloom is dissipating to Tier 1, consider replacing Tier 2 signage with Tier 1 signage.

***Establishing Rationale/Confidence for Action*:**

- Water tests indicate positive presence of blue-green algae above 100,000 cells/mL;

- **OR** verified pet illness/death;
- **OR** other analytical tests indicate a moderate probability of health risk **(TABLE A-1).**
- **All** water testing results should be verified with UDEQ-DWQ.

Tier 3 (High Probability of Public Health Risk)
This highest level of notification informs the public of water body closure in order to protect public health. As signage indicates **(Figure A-4)**, the public is advised to keep out of the area of the water body. Recreational and pet/livestock exposures to the waters of the lake have a high potential to result in adverse health effects. At this tier, LHDs should consider the following actions:
***Action*:**
- LHD should consider posting DANGER signs and consider closure of water body.
- LHD should notify the following agencies that action level has increased:
  - UDEQ-DWQ
  - UPCC
  - UDNR, DWR
  - UDNR, Division of State Parks (if applicable)
  - UDOH
- Weekly sampling should continue until bloom dissipates.
- If sampling indicates that bloom is dissipating to Tier 2, consider replacing Tier 3 signage with Tier 2 signage.

Establishing Rationale/Confidence for Action:
- Water tests indicate positive presence of blue-green algae above 10,000,000 cells/mL;
- **OR** verified human illness;
- **OR** other analytical tests indicate a high probability of health risk **(TABLE A-1).**
- **All** water testing results should be verified with UDEQ-DWQ.
- **Also,** prior to posting DANGER signage and closure of a water body, UDOH and UDEQ recommend that LHDs consider consultation with the following agencies:
  - UDEQ-DWQ
  - UDNR, DWR
  - UDNR, Division of State Parks (if applicable)
  - UDOH
  - UPCC

Web Page Resource and Agency Points of Contact
UDEQ's Division of Water Quality will maintain an informational web page dedicated to Harmful Algal Blooms. Along with these guidelines and sampling protocols, the page will contain pictures that can be used to help in the positive identification of a harmful algal bloom and to differentiate such blooms from non-toxic green algae.

This page will also maintain an updated list of Points of Contact, for the various agencies that can provide HAB resource and consultation for the LHDs.

Guidance for Water Body Sampling
The recommended standard operating procedure (SOP) for collecting samples for HABs and HAB toxins are described in the Division of Water Quality's *Standard Operating Procedure for collection of Phytoplankton Samples During Harmful Algal Blooms*.

Communication with the Public

UDOH has developed a fact sheet for the general public on blue-green algae, the toxins they produce and their health effects. LHD officials are encouraged to use this fact sheet as part of their education and outreach efforts to the community. The fact sheet is included in **Appendix B**. UDOH and UDEQ will work closely with other agencies to develop additional communication messaging for use in harmful algal bloom events.

Fish Consumption from High Blue-Green Algae Count Areas

Some studies have shown that cyanotoxins can accumulate in fish to some degree in natural waters with high toxin levels. It is known that the body concentrations of cyanotoxins in fish are greatest in organs and fatty adipose tissue, with the lowest concentrations found in the muscle tissue (Zhang et al, 2009). While there have been no confirmed reports of cyanotoxin-related human health effects related to fish consumption, there are few data on cyanotoxins in lakes, fish, or shellfish to adequately base judgments regarding this health risk.

UDOH and UDEQ recommend careful cleaning and thorough cooking of fish harvested from waters where blue-green algae are present. This includes removing skin and fatty deposits from the fish and ensuring that the meat is well-rinsed before cooking.

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References and More Information (Click on links or use web address provided):

Photo Gallery of Green and Blue-green Algae (New York State Department of Environmental Conservation)
Available online at: http://www.dec.ny.gov/chemical/81962.html

Zhang D, Xie P, Liu Y, Qiu T, 2009. Transfer, distribution and bioaccumulation of microcystins in the aquatic food web in Lake Taihu, China, with potential risks to human health. The Science of the Total Environment [2009, 407(7):2191-2199]

WHO (2003) Guidelines for Safe Recreational Waters Volume 1 - Coastal and Fresh Waters
Available online at: http://www.who.int/water_sanitation_health/bathing/srwe1/en/

US EPA Contaminant Candidate List (CCL) and Regulatory Determinations
Available online at: http://www2.epa.gov/ccl

US EPA Creating a Cyanotoxin Target List for the UCMR (PDF) (17 pp, 110K; About PDF)
Available online at:
http://water.epa.gov/lawsregs/rulesregs/sdwa/ucmr/upload/2005_08_12_ucmr_meeting_ucmr1_may2001.pdf

WHO Blue-green algae toxins: Microcystin-LR in Drinking-water
Available online at: http://www.who.int/water_sanitation_health/dwq/chemicals/microcystin/en/

WHO (1999) Toxic blue-green algae in water: A guide to their public health consequences, monitoring and management
Available online at: http://www.who.int/water_sanitation_health/resourcesquality/toxcyanbegin.pdf

Prepared by the Utah Department of Health, Division of Disease Control and Prevention, Environmental Epidemiology Program with funds from the Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services and the Utah Division of Water Quality

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Appendix A
Decision-Making Tools and Signage Examples

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Figure A-1. Decision-making algorithm tool.

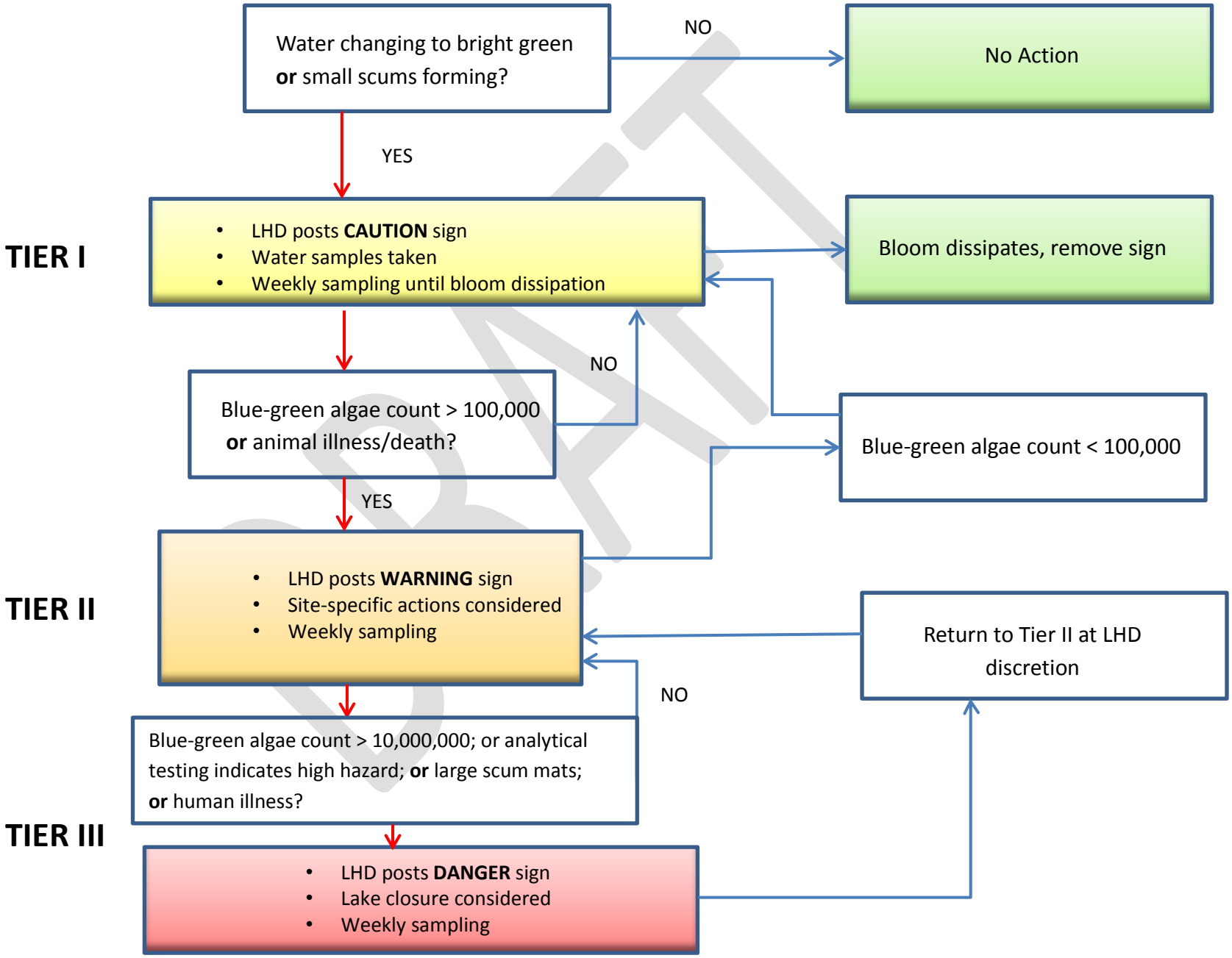

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Table A-1. Comparison of Cell Counts to Other Measurements of Harmful Algal Blooms from WHO (1999).

Relative Probability of Acute Health Risk	Toxin Producing Blue-green algae Cell Density (cells/mL)	Microcystin Concentrations (µg/L)	Anatoxin-A[1] (µg/L)	Chlorophyll *a* (µg/L)	Health Risks	Action Recommended
Very Low	<20,000	<4	<20	<10	Negligible	None
Low	20,000-100,000	4-20	NA	10-50	Short-term effects e.g. skin irritation, gastrointestinal illness	Issue caution advisory; Post **CAUTION** sign; Weekly sampling recommended
Moderate	100,000 – 10,000,00 or Reports of animal illnesses or death	20-2,000	NA	50-5,000	As above for low risk, and potential for long-term illness	Issue warning advisory; Post **WARNING** sign; Weekly sampling recommended
High	>10,000,000 or Large scum layer or Reports of human illness	>2,000	>20	>5,000	As above for moderate risk, and potential for acute poisoning	Issue Danger Advisory; Post **DANGER** sign; Weekly sampling recommended Consider **Closure**

Notes:
[1] From Oregon Public Health Advisory Guidelines
NA = None available

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Figure A-2. Example **Caution** Sign

CAUTION

TOXIC ALGAE MAY BE PRESENT

Lake may be unsafe for people and pets

Until further notice:

- **Do not swim or water ski in areas of scum.**
  No nade o practique el esquí acuático en áreas con espuma o verdín.
- **Do not drink lake water.**
  No tome el agua del lago.
- **Keep pets and livestock away.**
  Mantenga alejados las mascotas y el ganado.
- **Clean fish well and discard guts.**
  Limpie bien el pescado y deseche las tripas.
- **Avoid areas of scum when boating.**
  Evite las áreas con espuma o verdín cuando ande en lancha.

Call your doctor or veterinarian if you or your animals have sudden or unexplained sickness or signs of poisoning.

Report new algae blooms to the Department of Environmental Quality:	Call your local health department:

Utah Poison Control Center

1-800-222-1222

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY

UTAH DEPARTMENT OF HEALTH

Figure A-3. Example **Warning** Sign

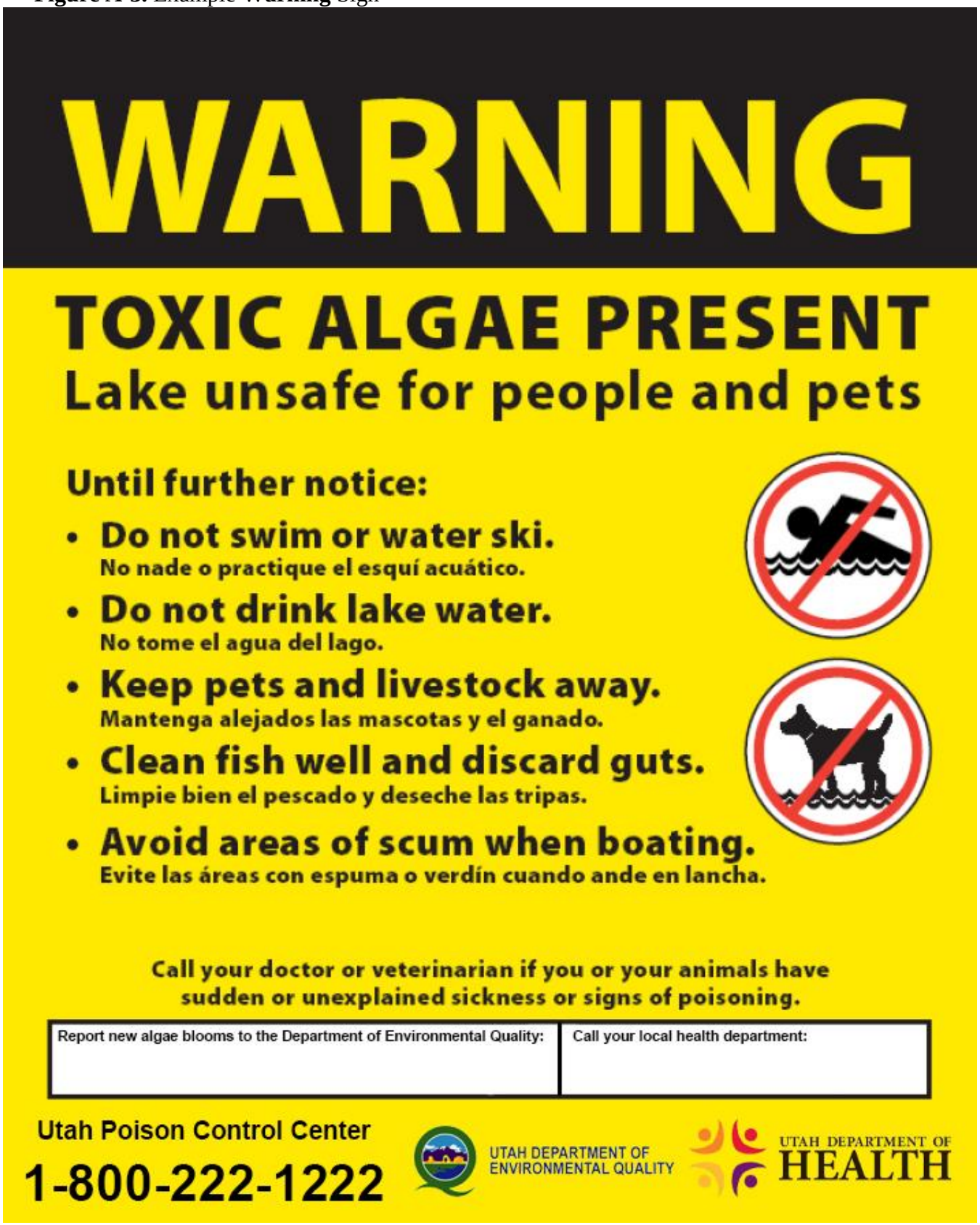
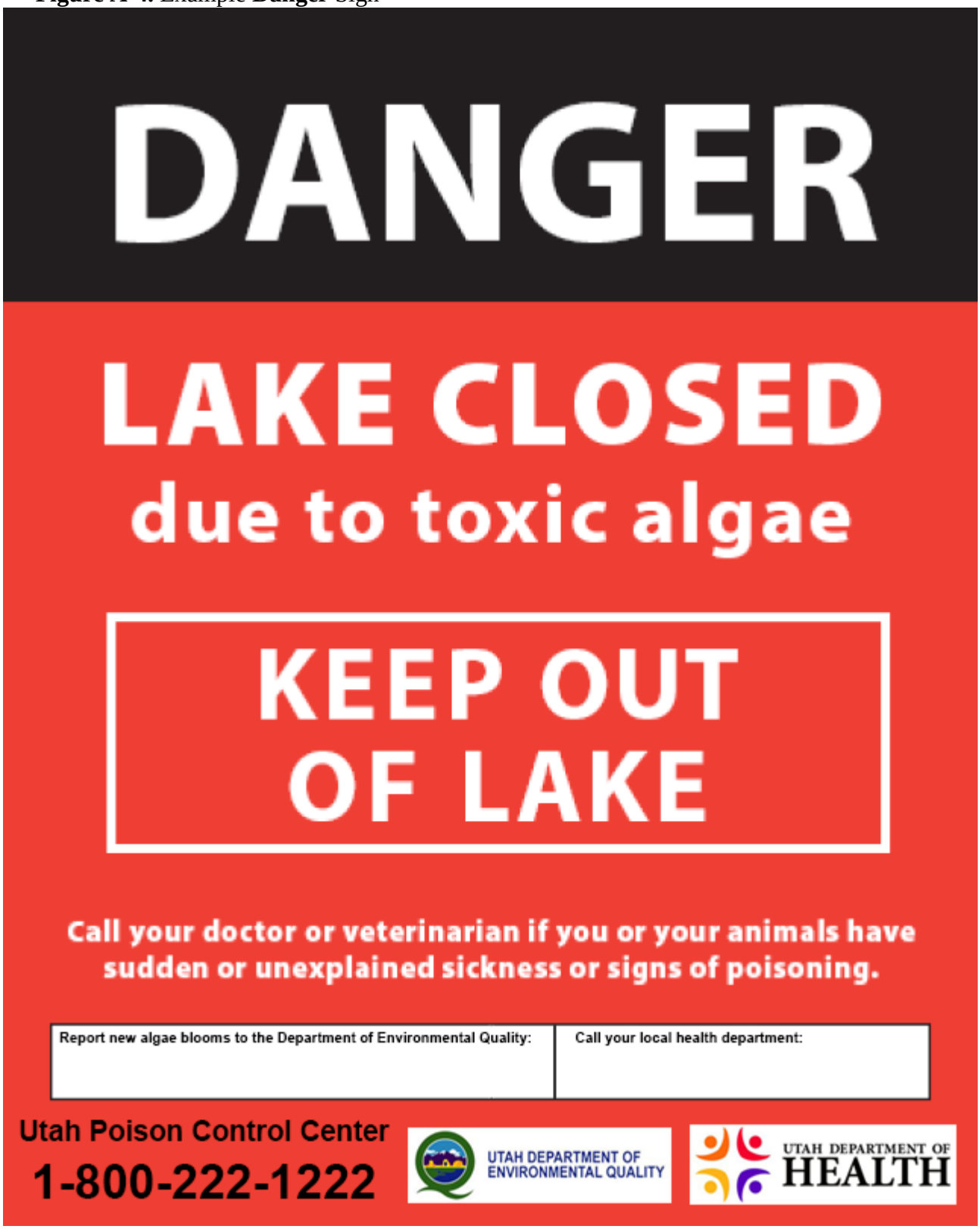


Figure A-4. Example **Danger** Sign



Appendix B
Fact Sheet

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Fact Sheet: Harmful Algal Blooms in Utah Lakes

Harmful algal blooms (HABs) are the result of a rapid increase or accumulation of algae on the surface of a water body. Cyanobacteria (or blue-green algae) can flourish and cause blooms in Utah lakes when nutrients, sunlight and temperatures are just right. Some types of blue-green algae can produce toxins which can harm the liver or nervous systems of humans and animals. The algae itself can cause rashes in contact with skin, or stomach and lung problems if it is swallowed or get inhaled by accident.

How Can I Tell if the Water is Safe?

You may see these blooms on ponds and lakes throughout Utah. They can be a variety of colors, such as fluorescent **blue**, **green**, white, **red** or **brown**. More than one color may be present. They may look like thick paint pools floating on the water and frequently give off a foul odor.

The Dos and Don'ts of Harmful Algal Blooms

DON'T swim, water ski or boat in areas where the water is discolored or where you see foam, scum or mats of algae on the water.

DON'T let pets or livestock swim in or drink from areas where the water is discolored or where you see foam, scum or mats of algae on the water.

DON'T let pets lick algae off of their fur.

DO rinse yourself and your pet immediately if there is contact with algae-affected waters.

DO look for beach postings and water quality notices before swimming.

DO get medical treatment right away if you think you, your pet or your livestock might have been poisoned by algal toxins.

Potential Symptoms

Blue-green algae related illness becomes a concern in Utah as the weather warms and people and pets spend more time outside on or near lakes. Illnesses can be caused by toxins produced by the algae or by the algae themselves. Symptoms will vary depending on the type of exposure.

The most common exposure for **people** is **skin contact** with scum or water containing algae cells or toxins.

HAB-Related Skin Rash

People may also **inhale** tiny droplets of water containing toxins or cells; this is most common when people are water skiing, wakeboarding, etc.

The most common exposure for **animals** is **ingesting** water with toxins or algal cells.

Common <u>Human</u> Symptoms Include:

Sore throat, congestion, cough, wheezing, eye irritation, rash, blistering, abdominal pain, headache, vomiting and diarrhea.

Common <u>Animal</u> Symptoms Include:

Vomiting, lethargy, diarrhea, convulsions, difficulty breathing and general weakness.

If you need urgent information related to a suspected algal exposure, call the
Utah Poison Control Center:
1-800-222-1222.

For more information:
Ben Holcomb, Division of Water Quality, 801-536-4373

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